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Theorising schools as organisations: Isn't it all about complexity?

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Theorising schools as organisations: Isn't it all about complexity?

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Abstract

The daily work of organising in schools both configures and is configured by the nature of schools as complex organisations. However, the organisational complexity of schools is often omitted in normative and analytical accounts of schools as organisations. In this paper, we seek to redress that omission and to bring organisational complexity to the fore in theorising about educational organisations and organising. Using a meta-ethnographic approach, we analyse the literature on organisational complexity and loose coupling. We develop and explain the elements of a perspective on schools as complex, evolving, loosely linked systems (CELLS). Using this perspective, we consider significant aspects of schools from this perspective with the intention of establishing its validity and relevance to organisation theory in education.

Key Words

School leadership

School management

School organisation

Organisational complexity

Loose coupling

Complex, evolving, loosely linking systems

CELLS

Introduction

The ideas, concepts, and theories from the complexity sciences have slowly but steadily gained credibility in the social sciences. Importantly, they are being used more widely and public administration, public policy, and public management research (Gerrits and Marks, 2015). Arguably, the application of complexity theory is still relatively underdeveloped in educational research (Harcourt-Heath, 2013) possibly because education has not had the paradigm shift that has occurred in the business sector (McMillan, 2004) and because there is a strong methodological paradigm attached to educational research (Byrne and Callaghan, 2014). However, complexity theory in educational research is now beginning to establish itself and increasingly the complexity frame of reference is being used in educational research (Byrne and Callaghan, 2014).

Apart from a small number of exceptions, for example, Morrison (2002; 2010), who has analysed the leadership implications of complexity, and Goldspink (2007) who has analysed system reform processes from a complexity standpoint, complexity theory has not been used in the analysis of organisational practices in schools and school systems. Indeed much research on schools as organisations, for example school effectiveness research, appears to ignore their complex nature adopts a linear, rational and deterministic world view, and applies reductionist methods (Cunningham, 2004). The lack of use of complexity theory in organisational theory in schools is ironic given that 40 years ago Weick (1976) defined the organisational characteristics of schools as loosely coupling and in so doing drew attention to their organisational complexity. The complexity and loose coupling of schools as

organisations both configures and is configured by the daily work of organising in schools. Somewhat paradoxically, in the 40 years since Weick's study, the use of the complexity perspective has grown in a range of disciplines including organisation theory/studies, although its place in theories of schools as organisations is not prominent. The organisational complexity of schools and their loosely coupling nature is often omitted in normative and analytical accounts, although some authors, notably Goldspink (2007) does so explicitly. In this paper, we seek to redress that omission and bring organisational complexity to the fore in theorising about educational organisations and organising.

In this paper, we review and then analyse the literature on organisational complexity and loose coupling using a meta-ethnographic approach. From that analysis, we develop and explain the elements of a perspective on schools as complex, evolving, loosely linking systems (CELLS). Using this perspective, we consider significant aspects of schools. The overall intention of the article is to establish the validity of the CELLS perspective and its relevance to organisation theory in education.

Following this introduction, we present an overview of the notion of complexity and then explain the method we used to synthesise the CELLS perspective. In the subsequent section, we present the outcomes of our analysis. We then consider aspects of organising in schools from the CELLS perspective and the article ends with a short summary and some concluding comments.

Complexity: An overview

In this section, we give an overview of the notion of complexity, discussing it and exploring its meaning. We also introduce the characteristics of complex systems and different perspectives – complex adaptive systems, complex responsive systems and complex evolving systems. These different standpoints have a great deal in common. We also review the notion of loose coupling and consider the way organisational complexity has been applied in educational contexts, and the section ends with a brief summary.

Complexity as a concept

An initial understanding of the meaning of 'complexity' can be achieved by considering the difference between the terms 'complex' and 'complicated'. For Cilliers (1998), an object that can be completely described in terms of its individual components, is merely complicated, even one that consists of large number of components. An entity is complex when the interaction among its constituent parts and between the entity and its environment are such that it cannot be fully understood simply by analysing its components.

Complexity is a wide-ranging concept; it has been applied in various contexts and has a long history (Alhadeff-Jones 2008). There are 'complexity theories' but no overarching definition of complexity theory (Morrison, 2010). Kuhn (2008) in discussing complexity and education, uses the word 'complexity' as an abbreviation of complexity theory or complexity science. The idea of complexity has been used in the fields of: automata and cybernetics as organised complexity; game theory, problem solving, and artificial intelligence as algorithmic complexity; and evolutionary biology and the chaotic nature of evolution, where the term 'complex adaptive system' was developed. In relatively recent times, the notion has been applied to organisations, see for example, Stacey (1996). The literature reflects that usage: in science, computing and more recently in complex human systems. Complexity is thus widely defined and the lack of consensus on an overarching definition of complexity theory is open to criticism because it indicates a lack of coherence (Morrison, 2010). Alhadeff-Jones (2008) warns against reducing the field of complexity to a single definition. Doing so would lead to a neglect of the different theories that deal with the implications of the notion of complexity.

Complexity is a young theory which may explain the large number and diversity of definitions (Morrison, 2002; Gell-Mann; 1995).

Complex (human) systems

In complex human systems, because of the nature of the interactions between the components, the ‘whole is more than the sum of its parts’ (Holland, 2014). For complex human systems these interactions change those interacting in ways that cannot be predicted. The relationships between the parts are not fixed, but shift and change, often as a result of, and resulting in, self-organisation. These characteristics can give rise to novel features, usually referred to as emergent properties. The notion of emergence is an important defining characteristic of complex systems (Boulton et al., 2015; Holland, 2014; Cilliers, 1998) and leads various theoreticians to describe complex systems as adaptive (Holland, 2014); responsive (Stacey, 1996), or evolving (Mittleton-Kelly, 2003). Complex systems cannot be analysed using reductionist methods because of their emergent properties. The other primary characteristic of complex systems is that their large number of parts interact both with each other and the environment, and consequently, cause and effect is non-linear. As a result, predicting future system events on the basis of past events is not possible.

Complex adaptive systems

A number of people have put forward particular models of complex adaptive systems, for example, Gell-Mann (1994), Holland (2014), Jantsch (1980), Maturana and Varela (1992), and Prigogine and Stengers (1984). Holland (2014) states that complex adaptive systems are composed of elements, called agents that learn or adapt in response to interactions with other agents. He summarises the nature of complex adaptive systems as follows. They:

- exhibit lever points, which are small directed actions that cause large changes in aggregate behaviour
- display emergence
- exhibit adaptive interaction, that is, learning from past events
- follow non-linear cause and effect, and so can be unpredictable as aggregate behaviour can rarely be totally set by a central authority
- co-evolve, in a hierarchical generative processes
- can display chaotic behaviour, where small changes can lead to big changes, and where rare events happen more often than would be predicted.
- are those systems where the behaviour of the whole complex adaptive system is cannot be gained by summing the behaviours of the component agents: ‘the whole is more than the sum of its parts’.

Gell-Mann (1995) states that complex adaptive systems can make mistakes. People can mistake randomness for regularities because they can only perceive a small part of world and only know so much. Individuals try to identify patterns in everything. Gell-Mann explains that this characteristic explains how incorrect belief systems develop, which calls for the significance of false regularities to be examined. The characteristics of complex adaptive systems could also become a way of explaining why organisations sometimes fail. Individuals, as we as adaptive agents, sometimes perceive irregularities as regularities.

Holland (2014) admits that the study of complex adaptive systems still in the early stages. It is incomplete but nonetheless the pieces that exist suggest the possibility of an overarching theory. Mittleton-Kelly (2003) raises issues related to using complex adaptive system theory to research human social organisations. Stacey (2011) has questioned complex adaptive system theory for its system-driven, cybernetic, mechanistic connotations, and prefers the

term 'complex responsive process' as it connotes more of human relations and combines agency and mutual influence of individuals and groups. He asserts that complex adaptive system theory must incorporate the notion of heterogeneous agents, as these types of entities will demonstrate self-consciousness and therefore interact in ways different from those of homogeneous agents. Eoyang (2006) is of the view that complex adaptive system theory can be applied appropriately to human systems because people are consciously aware, learn from the past and attempt to alter future patterns. Eoyang (2006) combines complex adaptive system theory with human dynamics which she uses to apply to organisational research. Dooley (1997) draws attention to the often unrecognised paradoxical nature of complex adaptive systems – between order and randomness, control and freedom and learning and unlearning, adaptation to the system environment and construction of the system environment. For Stacey, (1996) complex adaptive systems are characterised as being webs of non-linear feedback loops that are capable of operating in states of both stable and unstable equilibrium - “*in bounded instability at the edge of chaos*” (Stacey 1996: 349). They are paradoxical in nature; have organisational dynamics characterised by regular and irregular trends; and even when successful “*face completely unknowable futures*” (Stacey 1996: 349) and indeed do not control their long-term future. Stacey (1996) argues that the managers of complex adaptive systems have to create and discover their system’s long-term future.

Complex responsive systems

Although Stacey (1996) argued the case for complex adaptive systems, in his later work, Stacey (2011), he takes a more radical approach. He argues that an approach that focuses on responsive processes where the detail of local interaction between individuals is significant. It configures experience, emergent identity and transformation; emphasises the importance of the informal and the narrative; and stresses the significance of conflicting constraints emerging as power and the dynamics of inclusion and exclusion. For Stacey (2011), these responsive processes bring about the simultaneous emergence of continuity and novelty, creation and destruction, in the iteration of nonlinear interaction and its amplification of small changes.

Complex evolving systems

In her work on complex (organisational) systems, Mittleton-Kelly (2003) characterises complex evolving systems on the basis of: self-organisation, emergence, connectivity, interdependence, feedback, dis-equilibration, space for possibilities, co-evolution, historicity and time, and path dependence. In co-evolution, the notion of joint development/change with other entities rather than adaptation to other entities is important as is the idea of deliberate intentional action by agents in the relation to the environment. She argues that entities do not simply adapt to their environment, they co-evolve with the environment, which is why she rephrases a complex evolving system as a complex co-evolving social system. If reciprocal influence between interacting affects the behaviour of interacting entities then there is co-evolution, if it is one way then it is adaptation (Mittleton-Kelly, 2009).

The notion of loose coupling

The long-standing notion of loose coupling (Weick 1976) clearly presages a complexity perspective on organisations. Using schools as the paradigm, Weick (1976) argued that in complex organisations, the linkages between individuals/events/entities may: be weak; happen infrequently; break; and change over time. In loose coupling, the linking units jointly interact in a mutually responsive manner yet they remain distinct and maintain a separate identity. Importantly, he argued that this loose coupling is the ‘glue’ that holds organisations together.

Weick (1976) proposed a range of functions for loose coupling. It: enables 'good aspects' of an organisation to persist (and of course 'bad aspects'); provides multiple sense-making perspectives, especially environmental sense-making; enables swift, economical and substantial adaptations at a local level although the challenge of standardisation is exacerbated; enhances problem-solving capability; enables adaptability, and allows the impact of local functional breakdowns to be contained, although this 'sealing off' can make repairing defective element difficult.

Weick subsequently identified four main tenets of loosely coupled systems (Weick 1982) They are self-correcting rational systems among interdependent people; a consensus on goals and the means to attain them is important; the dissemination of information is central to system coordination; and predicting problems can be difficult but multiple responses to problems are available when they do arise. Subsequently, Orton and Weick (1990) argued that retaining a dialectical interpretation of loose coupling is important: the (loosely coupled) parts are both responsive and distinctive. Used in this way loose coupling can be used to: understand what the organisation is; identify, measure, and understand interpretive systems; and understand the fluidity, complexity, and social construction of organisational structure. They also argued for a process perspective; that is, 'some organisations are characterised by loose coupling' as opposed to 'some organisations are loosely coupled'.

Complexity and educational organisations

The notion of complexity has been used less in education than other social sciences (Davis and Sumara 2006) but applying the ideas of complexity to education is increasing, see for example, Goldspink (2007), Morrison (2002; 2010) and Snyder (2013). Typically, the literature focusses on complexity and teaching and learning, see for example Complicity (2016). Apart from some notable exceptions, for example, Morrison (2002; 2010), published works on complexity and school organisation are relatively few in number. Although he does not specify his particular perspective on complexity theory, Morrison (2010) argues that it has much to offer school leadership and management but that perspective should be used with care. He raises a number of caveats: complexity theory's lack of clarity; its potential for 'ideology status'; its potential to confuse explanation and prediction; its relativist nature; the way it appears to advocate self-organization; its neglect of the ethical and emotional aspects of leadership and management; and its potential for freeing school leaders and managers from legitimate expectations of responsibility and accountability.

Summary

Complexity has been used in a range of disciplines. The application of a complex systems perspective to organisational theory is relatively new. The different standpoints: adaptive (Holland, 2014); responsive (Stacey, 1996); evolving (Mittleton-Kelly, 2003); and loose coupling (Weick 1976) are closely related and have significant aspects in common. The notion evolutionary process is an important commonality. In essence, in human/organisational systems, interactions change those entities interacting in ways which are carried forward into future interactions resulting in emergent features and patterns, which in turn condition future interactions. The idea of deliberate purposeful intentional interactions by entities in the relation to the environment and to other entities is important; interactions do not typically occur randomly. The use of the perspective has value but as Morrison (2010) argues, it needs to be exercised with caution, especially if used normatively rather than analytically.

Methods

Systematic review of literature

The research entailed undertaking a qualitative synthesis (Noblit and Hare, 1988) or meta-ethnography. We carried out a review of published studies that have applied complexity theories to the analysis of organisations and then identified themes in the literature. Evaluations of meta-ethnography (Britten et al., 2002; Campbell et al., 2003) indicate its value in producing middle-range theories with greater explanatory power than could be achieved in a narrative literature review.

Qualitative synthesis has been used in research projects similar to the synthesis attempted here. Barnett-Page and Thomas (2009) and Goldspink and Kay (2003) created a synthesis of autopoietic theory and complex adaptive systems theory and applied it to the study of organisations. Mena (2003) has applied the general principles of complexity theory in a specific manner in order to create a model of complexity to be applied in an organisational context.

Thus far we have analysed 11 very diverse sources that cover the range of perspectives described above. We have deliberately not included Weick's (1976) at this stage or works that refer to it preferring to focus on the sources that have applied complexity theory to organisational study. In our presentation of the outcomes of our analysis we do relate the emergent themes to Weick's work, as appropriate.

Outcomes of the synthesis

In this section, we present a preliminary analysis of the themes identified. For each theme, we describe the theme indicating its prevalence in the literature, describe the way it is present in the various sources. The sources analysed are:

1. Holland (2014):
2. Gell-Mann (1994)
3. Mittleton-Kelly (2003)
4. Stacey and Mowles (2015)
5. Goldspink and Kay (2003)
6. Snowden and Boone (2007)
7. Mena (2003)
8. Falconer (2002)
9. Eoyang (2006)
10. Dooley (1997):
11. Goldspink (2007)

Theme 1 Non-Linear cause and effect

Cause and effect are difficult to ascertain in a non-linear system due to the number of systems and subsystems interacting with both each other and the environment. The theme is very prevalent as can be seen below.

1. Holland (2014):
2. Gell-Mann (1994): Feedback in complex systems is non-linear.
3. Mittleton-Kelly (2003): Entities interacting together create complex inter-relationships. Mittleton-Kelly (2013): Co-evolution is unpredictable and non-linear, because evolutionary dynamics are reactive rather than predictive.
4. Stacey and Mowles (2015): Systems are non-linear.
5. Goldspink and Kay (2003): Systems cannot be modelled as non-linear. The combined effect of heterogeneity of individuals and this highly plastic basis of interaction adds significant non-linearity.
6. Snowden (2007): Interactions are non-linear.

7. Mena (2003): Chaotic behaviour is non-linear and chaotic behaviour can be present in business organisations.
8. Falconer (2002): Challenge the assumptions that change is linear and that it is discrete. The more the system involves animate objects—people, the natural environment, and so on the more certainly it will be rooted in nonlinearity.
9. Eoyang (2003): Individual and small groups interact in unpredictable ways so patterns only emerge over time.
10. Dooley (1997): CAS are typified by nonlinear flows of information and resources.
11. Goldspink (2007): The focus of complexity theory is on understanding the implications of systemic non-linearity. This challenges the Newtonian foundations of much contemporary management and economic theory and the assumption that order in social systems arises primarily from rational control.

In schools, non-linearity of the system and the complex inter-relation between cause and effect are potentially challenging. For example, a question could be asked as to whether it is the teacher intervention or other factors, such as learning from peers/outside the classroom, that have had an impact on student attainment. The implication for schools is that attributing effects to any particular causes becomes difficult.

Theme 2 - The whole is more than the sum of the parts

As a result of interaction, the system in its entirety is greater than the individual constituent parts. This theme is not a robust, perhaps because of its colloquial nature.

1. Holland (2014): The whole is more than the sum of its parts.
2. Snowdon and Boone (2007): The whole is greater than the sum of its parts.
3. Mena (2003): The whole is more than the sum of its parts.

For schools, this theme draws attention to the significance of interaction, which if productive and synergistic can add significantly to individuals' endeavours, with the implication that collective endeavour amongst the teaching staff is important, as is the collaborative strength of the staff group (James et al., 2006).

Theme 3 Emergence

Emergence is the idea that organisational properties emerge through the interactions of the organisational actors. Those individuals change as a consequence of interaction and the organisation develops properties which are individually and collectively manifested. Weick (1976) argued that in complex organisations, the linkages between individuals/events/entities may change over time. The notion of emergence is a prevalent theme in the literature as indicated below.

1. Gell-Mann (1994): Fitness emerges.
2. Mitleton-Kelly (2003): Complex evolving social systems can create new order.
3. Stacey and Mowles (2015): local interaction produces emergent global pattern without any 'direction' from a 'centre' in the form of global laws or designs that are to be realised or implemented.
4. Goldspink and Kay (2003): An emergent domain arises from the interactions of the entities.
5. Snowdon and Boone (2007): The system is dynamic, and solutions cannot be imposed; rather, they arise from the circumstances.
6. Mena (2003): Emergence refers to those properties of a system which are beyond the properties of any of its components.

7. Eoyang (2006): Emergent changes in structure result from internal dynamics and interactions rather than external influences.
8. Dooley (1997): The system behaves/evolves according to two key principles: order is emergent as opposed to predetermined, and the state of the system is irreversible and often unpredictable.

In schools, although there may be formal structures, such as departments and faculties, group behaviour is emergent. For the system, learning is emergent. Individual system members have consciousness, which has emergent properties.

The implications for schools include not being able to understand the school as an institution by just looking at its parts. The parts of the system need to be viewed and then the whole. Emergence means we cannot predict the future based either on the past or present; emergence is unique.

Theme 3 Patterns

Patterns can emerge but over time. They cannot be predicted because of non-linearity and emergence in the system. This theme features strongly in the literature as follows.

1. Gell-Mann (1994): Complex adaptive systems sense patterns around them and compress into a schema, each of which provides some combination of description, prediction and prescriptions for action.
2. Stacey and Mowles (2015): Local interaction produces unpredictably predictable, emergent, population-wide patterns.
3. Falconer (2002): Often the same/similar type of change recur numerous times, or generates similar change cycles but that differ in scope or scale.
4. Eoyang (2006): Patterns forming in a complex adaptive system can be anticipated.
5. Goldspink (2007): Complex systems are systems of large numbers of agents in highly connected webs.

Patterns of a range of kinds may emerge in a school which may be productive in terms of the work of the institution or not. Such patterns may be resistant to change but can be changed and do change sometimes quite rapidly. How we experience the school is bounded by existing knowledge of what schools are like and what they should be like (Goldspink 2007).

Theme 4 Chaos and stability

1. Mitleton-Kelly (2003): When a social entity is faced with a constraint, it finds new ways of operating. Systems are forced to experiment and explore possibilities.
2. Goldspink and Kay (2003): Complex systems can be stable, little change may happen for a while.

In schools, this aspect may become evident when small changes disrupt patterns in unexpected ways, for example, a school may temporarily move into a disordered, confused, disorganised state because of changes to key members of staff. For schools, arguably attempting to provide a containing environment may be more appropriate than providing a controlling environment (Dale and James 2015).

Theme 5 Unpredictability

1. Stacey and Mowles (2015): Local interaction can produce unpredictably predictable, patterns
2. Snowdon and Boone (2007): In ordered systems, the system constrains the agents and in chaotic systems, there are no constraints. However, in complex systems the

individuals and the system constrain each, particularly over time, which means that future outcomes cannot be forecast or predicted.

3. Falconer (2002): The same or a similar types of change may recur, or initiate broadly similar change cycles although different in scope and scale. This form of renewal is not predictable.
4. Eoyang (2006): Individuals or groups interact in unpredictable ways with system-wide patterns emerging.

Being unable fundamentally to predict the future presents those in schools with a paradox: they must both plan for it on the basis of those prediction but understand that such predictions are invalid. Focused prediction of the future, even the near future, is very difficult as there will always be small perturbations affecting the outcome of actions. Those in schools may seek to protect themselves from the anxiety associated with this untenable position. For schools, target setting, especially long-term target-setting becomes very difficult. It is impossible to predict what will happen in the future.

Theme 4 Self-Organisation (without the need for a plan)

This theme relates to the notion that people within complex systems can and may well self-organise for a variety of reasons but arguably they will do so if they experience a need to create more stability. They may well do so without following a centrally specified plan. Although Weick (1976) did not refer to the property of self-organisation in this way, it clearly featured in his notion of loose coupling. He refers explicitly the (loosely coupling) system making rapid, economical and significant adaptations and having the property of self-correction. This notion of self-organising without the need for a plan is a very prevalent theme in the literature.

1. Gell-Mann (1994): Self-organising will be context dependent.
2. Middleton-Kelly (2003): Complex systems are self-repairing and self-maintaining.
3. Stacey and Mowles (2015): Since the persons comprising an organisation are interdependent, it follows that none of them can simply choose what is to happen to all of them. What happens to all of them will emerge in the interplay of their intentions, and no one can be in control of this interplay.
4. Goldspink and Kay (2003): Order in the absence of external direction is common in complex systems.
5. Snowden and Boone (2007): Humans can, in certain circumstances, purposefully change the systems in which they operate to equilibrium states in order to create predictable outcomes.
6. Mena (2003): Definitions of self-organisation vary slightly.
7. Falconer (2002): Not mentioned.
8. Eoyang (2006): Emergent, system-wide patterns are said to “self-organize” in the system over time because changes in structure result from internal dynamics and interactions rather than external influences.
9. Dooley (1997): Refers to Prigogine and Stengers (1984), among others, who describe how order can arise from complexity through the process of self-organization.
10. Goldspink (2007): Importantly, order in complex systems is usually a result of micro-structuring processes that provide for robust self-organization.

Teachers are likely to respond to events in self-organising manner, without the need for central direction. Teachers and groups of teachers can re-order and organise aspects of schools. Despite any desire of policymakers and school leaders to control events, teachers will be interacting and re-organising on a continual basis.

Theme 6 - Interaction/ interdependence among subsystems and/or environment

Heterogeneous agents interact with each other and their environment continuously, these interactions determine the outcomes of actions. However, due to the uniqueness of interactions prediction is impossible. It is a very robust theme in the literature and the notion of interaction/inter-dependence is central to Weick's (1976) loosely coupling perspective.

1. Mitleton-Kelly (2003): Entities interacting develop complex inter-relationships, the nature of which cannot be predicted. They can change their rules of interaction and are able to act on limited local knowledge. They do not need knowledge of the whole system.
2. Stacey and Mowles (2015): The complex responsive processes perspective stresses human interdependence and the notion that individuals are 'social selves' and arise through human interaction. That interaction is the complex responsive process of human relating.
3. Goldspink and Kay (2003): In human social systems recurrent interaction is being continually maintained in a dynamic intertwining networks of linguistic, behavioural and affective interaction.
4. Snowden and Boone (2007): Interaction is a feature of complex (human) systems. In ordered systems, the system constrains the agents, while in chaotic systems, there are no constraints. In a complex (human) system the agents and the system constrain each other over time.
5. Eoyang (2006): A complex adaptive system is a collection of semi-independent agents that have the freedom to act in unpredictable ways, and whose actions are interconnected such that they generate system-wide patterns.
6. Goldspink (2007): Coupling (interaction) may include formal and informal, rational and emotional interactions (2007).

Arguably, all those in schools are interacting with each other and the environment all the time. Similarly, the students continually interact, as do those in the school's wider environment.

Theme 7 – Variety/Heterogeneity

A complexity perspective acknowledges the variety and heterogeneity of actors/elements in the system, indeed some authors see it as important and a prerequisite of system evolution – see for example, Mitleton-Kelly, 2003) It thus features significantly in the complex evolving system perspective.

1. Mitleton-Kelly (2003): Argues that there must be heterogeneous agents within the system. It provides the requisite variation for adaptive selection (see the notion of competition below) which is vital for system evolution.
2. Mena (2003): Refers to Ashby (1956) who suggested variety as a measure of systemic complexity, referring to the number of distinguishable elements in a system, or the number of distinguishable systemic states.

A consideration of schools as complex systems needs to recognise and arguably encourage the diversity of elements 'within the organisation' and 'within the environment of schools'. The complexity of schools cannot be limited to a consideration of the nature and practices of the staff group.

Theme 8 - Feedback

Feedback can affect future actions in different and unpredictable ways. Sometimes feedback can bring about large effects, perhaps larger than the initial interaction. Importantly, feedback can be negative and inhibitory, or positive and reinforcing, and can change in nature and extent rapidly. It features in the literature as follows.

1. Gell-Mann (1994): The outcomes of a schema in a complex system feedback and affect the schema's standing in relation to the other schema with which it is in competition.
2. Mitleton-Kelly (2003): Feedback influences potential action and behaviour. In human interactions feedback is not likely to be straightforward as in a cybernetic system conceptualisation.
3. Stacey and Mowles (2015): The system operates according to both positive and negative feedback. As a result, the system may display unstable/non-equilibrated behaviour as it switches between positive and negative feedback. Patterns of system are more complex and dynamic over time.
4. Goldspink and Kay (2003): In social systems, people may observe consequences at the macro level and change their behaviour accordingly. Thus in human social systems direct feedback from macro to micro is possible unlike natural systems.
5. Mena (2003): Feedback is a process by which information generated by an action is used for the decision-making or regulation process, to affect the next action a view reflecting that of Stacey (1996).

In schools, feedback is continually evident as members of staff interacting and teachers interacting with students provide negative corrective feedback and positive reinforcing feedback. The practices that receive positive and negative feedback are significant. Changes to the positive or negative nature of feedback will be experienced powerfully.

Theme 9 - Competition

In complex (human) systems emergent properties will be subject to 'competitive pressure' as they interact with other properties. Some emergent properties will be enabled/promoted, others will be disabled/supressed.

1. Gell-Mann (1994): The results obtained by a schema in the real world then feedback to affect its standing with respect to the other schemata with which it is in competition.
2. Mitleton-Kelly (2003): Fitness for survival is a feature of evolutionary biology relates directly to competition.
3. Stacey and Mowles (2015): People weigh-up and make choices on the basis of ideology. Conflicting/competing constraints emerge as power and the dynamics of inclusion and exclusion.
4. Mena (2003): Self-organisation is based on communication, collaboration and competition between the components of a system.
5. Dooley (1997): Schema exist in large number and compete for survival. Changes to schema are of three types: first-order, where action is taken to adapt the observation to the existing schema; second-order, where the schema is changed better fit observations; and third-order, where a schema either survives or not.

The ideas that gain ground through complex interactions and thus compete successfully with other ideas are important in complex systems. Here the notion of legitimacy begins to emerge (Suchman 1995). For schools, mandating what ideas are promoted through interactions becomes significant.

Theme 10 - Adaption or Co-Evolution

When agents interact with each other and the environment they adapt or mal-adapt depending on what is happening around them. Agents also co-evolve, which creates emergent properties. This notion is present in Weick's (1976) concept of loose coupling. He argues that loosely coupling systems be more responsive to small environmental changes and are able to adapt to such changes (Weick, 1982). Adaption/co-evolution is a very substantive theme in the literature.

1. Gell-Mann (1994): Systems behaviour and surroundings are often co-evolving.
2. Mitleton-Kelly (2003): Heterogeneous agents within the system provide the variation necessary for the adaptive selection crucial to evolution. These agents: interact, influence each other, learn, and adapt to circumstances.
3. Stacey and Mowles (2015): The detail of local interaction between diverse people patterns experience, enable emergent identities and can bring about transformation.
4. Goldspink and Kay (2003): Argue that self-organized criticality (Bak, 1996), which is the (quasi-stable) position between stable and chaotic behaviour confers considerable advantages. It provides systems with the maximum potential to conserve their adaptation in response to the widest possible range of environmental perturbations.
5. Snowden and Boone (2007): The system's past history is integrated with the present. The system elements mutually evolve and with the environment. This evolution is irreversible.
6. Mena (2003): Co-evolution is the result of the interaction of systems where the actions of one system affect another. Refers to Kauffman (1993) who asserts that co-evolution is similar to adaptation, but in this case, the system never reaches equilibrium and continues to develop, striving for progress.
7. Falconer (2002): In complexity theory, a complex adaptive system, or a system that changes its behaviour in response to its environment or its own circumstances.
8. Dooley (1997): The nature of change in complex human systems is dynamic and wide in scope. An entity within the system changes over time and so do the entities around it, and the external environment. This joint evolution is unidirectional.
9. Goldspink (2007): Local adaptations will not always assist with generating efficient responses to system-wide challenges. Loose coupling implies slow diffusion of central initiatives.

The purposeful interactions within a school, within a school's environment and between the school and its environment means that the school is in a continual process of change and adaption. The organisation is in a continual process of evolution. Despite powerful mimetic forces, each school is will be organisationally and contextually unique and will be developing and evolving as an institution. How it does so will depend on the agents within the whole system.

Theme11 - Small actions may have large effects

The notion that in complex systems small actions can have large effects is a significant theme in the literature. Weick (1982) draws attention to this issue arguing that loosely coupled systems react to relatively small actions but their tendency is to under-react. However, small actions in tightly controlled systems may cause an over-reaction. The reference in the complexity literature to this phenomenon are as follows.

1. Mitleton-Kelly: In far-from-equilibrium conditions, non-linear relationships prevail. As a result, referring to Prigogine and Stengers (1985), the system becomes

“inordinately sensitive to external influences. Small inputs yield huge, startling effects” [p. xvi] and the whole system may reorganise itself.

2. Stacey and Mowles (2015): Continuity and novelty, and creation and destruction, simultaneously emerge as nonlinear interaction play out and amplify small changes.
3. Goldspink and Kay (2003): Where systems are comprised of components with a high level of connectivity, it may take only a few sub-systems or components to exhibit non-linear or discontinuous characteristics for the whole system to then behave in a non-linear way.
4. Snowden and Boone (2007): Minor changes can produce disproportionately major consequences
5. Mena (2003): Argues that in chaotic systems, causes and effects become distant in time and space, due to the sensitivity of the system and the non-linearity of relationships.
6. Dooley (1997): Far-from-equilibrium conditions can be generated by trigger events such as crises or leader-declared revolutions. Unlike first-order adaptations, these crises overwhelm the organisation's normal capacity for change'

In schools and in other complex and highly interactive organisations, misunderstanding or incorrect information or misinterpretations may have substantial effects, with the implication that actions need to be thought through carefully and communicated clearly.

Theme 12 - Hierarchy

This idea relates to hierarchy and the emergence of it in complex systems. Elements within the system can be self-similar but without the lower orders, higher orders cannot be created.

1. Mitleton-Kelly: Hierarchy refers to the notion of nested subsystems. In systems theory, a subsystem is both part of the whole system and a whole system in its own right. Systems theory emphasises the wholeness of the part rather than the constitution or representative characteristics shown by that part. Emergent properties denote hierarchical levels in a complex adaptive systems and nest with other emergent system properties.
2. Stacey and Mowles (2015): From a responsive processes perspective, human actions are not hierarchical. They argue that individuals produce organisations as another level, or contribute to events, which shapes their identities, individual identities and the organisational are thought of as the same responsive processes
3. Goldspink and Kay (2003): People who have become structurally coupled can be considered as having formed higher order systems. Each such higher order system may be treated as operationally closed in that the recurrent interaction which gives rise to it is uniquely determined by the structures of the participants and their individual and collective histories of interaction. As higher order operationally closed systems they may become distinguished as new entities
4. Eoyang (2006): Changes at one level may influence emergent patterns at levels above and below. In the dynamic emergence of organizational change, changes at individual, group, departmental, and organizational levels of scale occur simultaneously each level influences the others
5. Goldspink (2007): The hierarchical form of order is not dependent on hierarchical control but is distributed and local in its operation. It can lead to macro- or system-wide stability or instability.

Hierarchies may emerge in schools of a variety of kinds – not just those that relate to the ‘formal’ structure. Further in schools, all subsystems are interrelated, they share similarities but are also different.

Synthesis of themes to form the model of schools as complex evolving loosely linking systems (CELLS)

From the preceding analysis, a number of robust themes emerge from the literature analysed thus far: non-linearity; emergence; patterns, chaos and stability, predictability, interaction, competition, variety and heterogeneity, feedback, adaption or co-evolution, small actions may have large effects, and hierarchy. We have illustrated each of these themes and discussed the implications for schools. We have not included Weick's work in the analysis at this stage preferring to view as foundational and therefore seeking to explain as appropriate the relationship between Weick's notion of loose coupling, which is grounded in an analysis of schools as organisations, and themes in the complexity literature.

From the analysis, we conclude that schools as loosely linking systems have the features of complex evolving systems. They are organisations: where purposeful interactions occur between varied heterogeneous actors; where properties and patterns emerge that are typically stable but potentially chaotic, and the nature of which can be difficult to predict; that are non-linear in nature so establishing cause and effect can be difficult; where small actions may have large effects; where feedback is of a range of kinds – positive and negative. They are thus in a state of continual evolution. As a consequence, we argue that schools can be described as complex evolving loosely linking (as we have referred to coupling) systems (CELLS) and that such a perspective on schools has validity.

Aspects of schools as organisations and organisational practices in schools in relation to a CELLS perspective

In this section, we consider a number of aspects of schools as organisations and organisational practices in schools in relation schools as complex organisations.

Leadership models: A wide range of leadership models have been advocated as appropriate in schools. Given the complex nature of schools, no single model universally and continually applied will be appropriate: the leadership context is too complex. Moreover, the leadership model adopted will be configured significantly by the context and its complex demands; the choice of leadership model may not be within the gift of the leader.

Transformational leadership (of a particular kind) and instructional leadership have been advocated as the appropriate model for school leadership (Day et al. 2010). In schools as CELLS that is unlikely to be so in every case; the diversity of contexts requires a more varied repertoire of leadership practices. However, transformational leadership in its original conception (Bass 1996) arguably engages an individual's intrinsic, inner motivations, while transactional forms with which it is often contrasted rely on harnessing extrinsic external motivations. Given the complex nature of schools, influencing individual's internal motivations coupled with authorisation (see immediately below) is likely to be effective. Further, Weick (1982) argues for consensus on goals and the means of attaining them in complex environments, which provides a rationale for engaging instructional leadership strategies. Others have advocated the significance of an organisation's primary task, see for example, James, et al. (2006), for the same reason.

Distributed leadership: Distributed leadership has been widely advocated as it brings a range of benefits such as democratisation, capacity building and efficiency and effectiveness (Mayrowetz, 2008). Distributed leadership is arguably about authorisation; an individual's power to influence (Cuban, 1988) has been legitimised in some way. Given the challenging of organising in complex settings it is easy to see the considerable benefits that arise from widespread authorisation.

The characteristics of teachers: The argument for considering teachers as professionals has a long-history and professionals can be characterised in a range of ways, for example, the work of professionals typically has a moral purpose; requires and confers considerable autonomy, entails a close relationship with ‘the client’; requires close responsive reflective interaction with the context; and carries an expectation of learning to improve practice over-time. Further, teaching is a vocation – people are called to it as an occupation. All these characteristics of teachers/school leaders both solve the problems of organising appropriately in schools and contribute to their complexity and looseness of coupling. However, the notion of professionalism and the characteristics of teachers raise issue of legitimacy; it becomes very significant in school organising given the nature of schools as CELLS

Organisational norms and culture: Norms are the prescribed and obligatory aspects of organisational life, which set out the preferred/desirable standards of organisational practice, specifying both processes and goals. Culture is concerned with shared notions of reality and sense-making frameworks for meaning-making and interpretation. It cultivates a particular collective thought-style and normative consciousness. Given the complex nature of schools, the considerable significance accorded to organisational norms and culture is understandable.

Participation of parents: The role of parents in their children’s education adds considerably to the complexity of schools. A substantial majority of organisation members - the students - are under the direct influence of a very influential group of adults over which ‘the school’ has no direct control. The organisational participation of parents considerably exacerbates the nature of schools as CELLS and therefore presents school leaders with considerable challenges.

Institutional autonomy: For many years, enhancing school autonomy has been a trend around the world. However, given the complex nature of schools, it contributes considerably to the organisational challenges of ensuring the proper conduct of schools. For those with single school/instructional responsibilities, increased autonomy extends and complexifies the organisational possibilities. For those with ‘central responsibility’ for an educational system comprising a large number of schools there is the challenge of what to control and mandate from the centre.

Organisational boundaries: The notion of the organisational boundary is a valuable and under-explored heuristic for the organisational analysis of schools (Eddy Spicer and James 2010). Arguably, organisational boundaries in schools as CELLS and between schools and their environments will themselves be very complex, occurring at numerous points of interaction between sub-systems, between individuals, and between and among events. Further, the nature of loose coupling changes the form of organisational boundaries and the underpinning boundary animating forces (Eddy Spicer and James 2010).

Organisational performance: Ensuring high levels of organisational performance is problematic because of the organisational complexity of schools. At the whole institution level, performance is contingent on a range of complex and loosely coupling interacting factors. Further, simple measures of the performance of complex organisations such as schools are unlikely to be adequate for capturing the organisation’s performance. The validity of school inspection, see for example (Ofsted 2014), is therefore problematic. At the individual teacher level, the complex nature of teachers’ working environment and its loosely coupled nature can make teacher performance management, which is arguably conceived as an instrumental technical exercise (DfE 2012), very problematic. Performance objectives may not be under the direct control of the teacher and the appropriateness of annually set objectives may change.

Governance of educational institutions: Schools are governed by a network of actors from all aspects of society – the market, civil society and the state. The interactions of this network which are arguably concerned with securing the legitimacy of schools as institutions are very complex (see Kooiman 2003). Further, the notion of what is legitimate conduct is open to debate and wide interpretation. The complexity of governance arguably exacerbates the complexity of the organisation of schools.

Summary and concluding comments

In this article, we have sought to bring organisational complexity to the fore in theorising about educational organisations and organising; integrate loose coupling theory and a complexity perspective on organisations; and explore the way the characteristics of schools as CELLS configure and are configured by organisational practices. We are conscious that the perspective raises a number of issues, especially those of an ontological nature. We argue that the CELLS perspective as an analytical construct, a perspective on schools as organisations and a descriptive heuristic is of value to both practitioners and researchers.

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